XXII. *A supplementary note on the specific modifications of Japan* Carabi, *and some observations on the mechanical action of solar rays in relation to colour during the evolution of species.* By George Lewis.

[Read October 4th, 1882.]

The paper I now offer to the Society was commenced in August to illustrate the climatical variations to which *Carabi* in Japan are subject, but the consideration of the relations of light to colour has crept into the article, and I have thought it well to leave the two subjects together, as they are closely connected, rather than separate them now. The paper is not scientific in any higher sense of the term than that attained by common observation; but perhaps later on I can refer to the subject of colour more fully. I hope there is something in the notes sufficiently tangible to incite discussion, if nothing more.

In the December number of the 'Entomological Monthly Magazine,' 1880, I described the peculiar geographical position of the Japanese islands, and gave some account of the climates of those regions in which the different species of *Damaster* originate, and I endeavoured succinctly to show that "in tracing *Damaster* from the south to the north, species became smaller, and step by step modified in form, with colour appearing the higher they go either in altitude or latitude." And I also pointed out that *Damaster* became diurnal in the north, where the warmth of sunshine was essential to it, and that with diurnal habits bright colours followed, according to the usually acknowledged laws of evolution. For as we ourselves fail to discern the fading colours of a landscape as night sets in, so Nature fails to perpetuate colour in nocturnal insects, colour itself being dependent on light-rays.

The colours of insects are often set down rather indefinitely to natural selection, in which sexual preference for beauty is supposed to be a considerable element; for it has been said, that after colour has appeared in a species, by some cause not explained, sexual selection can continue to improve it. But a truer explanation of insect-colour, to my mind, would be, if it could be shown that by little and little, in minute gradations, through long periods, sun-rays are the cause of it. And this, I think, is the origin of it, through what may be termed Photoplasticity, a photoplastic process by which the various rays or wave-movements from the sun impress living organisms with the structure necessary for colour. What we call bright colour does not exist in obscurity; light is necessary to appreciate it, and is, I think, the factor which produces it, and that nocturnal insects are black because they are not affected by the *direct* rays from the sun.

Professor Tyndall, in 'Forms of Water,' 1878, says of the wave theory of light, "It is because of its competence to explain all the phenomena of light that the wave theory now receives universal acceptance on the part of scientific men." So the theory of the mechanical action of light may be accepted as the cause of colour, if it is sufficient to explain the phenomena of colour; and it is the object of a portion of this short note to bring forward a few facts tending, as I think, to prove it.

Damaster blaptoides is a nocturnal insect; it is a night-rover, and during the day secretes itself in the rotten touchwood of old trees, remaining always well out of the light. *Noctuæ* are not nocturnal in this sense, as they are exposed to certain rays of light during the day. Some, e. g. *Aplecta tincta* and others, possess a colour called a protective colour, and rest on mottled moss-grown bark in the daytime, and it is then their colours are originated, not during flight, for their tints are not then visible, and it is on the upper wings alone that maculation appears. If we believe that there has been, and still is, a continuous modification of species throughout Nature, we must consider that the *Noctuæ* and the lichens have grown together, each out of some older form, sufficiently long to have been more or less modified side by side, as the contingencies of their existence dictated change; and, as their colours assimilate, we must, I think acknowledge, that they have acquired them by the same natural processes; say, for instance, in the subdued light-rays of an umbrageous forest. Let another instance be cited. Everywhere on the soil in summer time we see innumerable *Formicidæ*, active and bustling, running here and there in the sunniest places; some are fuscous, others reddish, but with them we do not see the flavous species. To find *Lasius flavus* we turn over stones, and then see the yellow worker, which burrows and remains in the nest under them; while the male and female more frequently leave the nests, and are less flavous. I have seen numbers of exotic *Formicidæ* of the same colour and habit, for, as it is under the shelter of the forest with the lichens and *Noctuæ*, so under the stones, there seems something in the nature of the shelter, to cause a peculiar colour, this time yellow. And, as a further indication of the same kind, we find a rufo-testaceous tint in *Claviger*, *Hetærius*, *Corythoderus*, *Paussus*, which reside in situations similar to those of the worker in *Lasius*. I have *Articeros* from the nests of a fuscous ant with nests under stones, but the instincts and habits of the *Formica* lead it abroad, and during daylight it continually sallies out and runs over the earth, returning to the nest only at intervals; while *Articeros* remains at home under stones, and, so hidden, retains its generic colour. With *Formica rufa* there are different coloured beetles, *Dendrophilus*, *Myrmetes*, &c., for neither the beetles nor the ants are subterraneous. In Japan there is a little gregarious beetle which consorts in societies under embedded stones, not in the open, but under large trees; it is one of the *Ozænidæ*, and has precisely the colour of the neuter of *Lasius flavus*. When colorous uniformity occurs in animals of widely different descent, yet living under the same conditions, the colours are probably of the same origin, for natural selection could not in any phase do more than continue or render persistent that which has been created by other means. Certain species of *Lampyridæ* are flavous, and in this colour are of world-wide distribution, but their habits are the same in all countries and under all climates, and we must not hastily say the colour is that of the group or family, or that it is hereditary, because, as I have said in regard to the yellow *Lasius*, the parents are *fuscous*, and it looks to me as though the conditions of life have more influence on colour than even parentage. And if the general principle of this is admitted, can the protective colour theory be allowed to occupy the position in our thoughts it has obtained during the past twenty years?

A few months ago I was observing daily *Phyllium Anthanysus*, which in Ceylon feeds on the leaf of the guava. Every nerve in the body of the larva of this insect corresponds to a vein in the leaf of its food-plant, and any one who is familiar only with the hard permanent forms in the fauna of Europe can hardly realise the degree of wonderment felt on seeing the insect alive for the first time. In life it has the beautiful greenness of the fresh guava leaf, and in death its tints fade gradually until it simulates in colour a dry specimen in the herbarium. Yet here I can only see peculiar form, for I believe the colour is of the same origin as in the leaf. No one can doubt the two things are connected, and have developed side by side, and I believe that the material substance of both is such that they absorb and reflect to us the same rays. In Ceylon, again, the larvæ of the *Daphnis nerii* feed on the recently-imported chinchona, and last January, in the early morning, I saw tomtits going the round of the plantations and feeding on the small caterpillars, which then measured about nine lines in length; the birds picked them off with the quick movements of their species, and without the least hesitation, evidently seeing the specimens clearly and at once. These larvæ were not protected by their colour, nor yet by their resting, after the manner of *Sphingidæ*, on the under side of the leaves, for I spent some time in searching in vain for overlooked larvæ after the birds had passed. In the young larvæ the side stripes and blue ocelli are scarcely visible; these beautiful and attractive markings do not develop conspicuously until the grubs are too large for the tomtits, so there is nothing in the stripes or eyes to disquiet the birds. Again, can we see protective colours in large *Carabi?* A fine *Carabus*, such as *rutilans* and *Hispanus*, can hold its own on a Spanish mountain slope against such enemies as it is now likely to encounter, and why at any antecedent stage of its earlier struggles shall we credit it with having more formidable opponents? If the conditions of its life were much altered, if the slopes were covered with dense forest, for instance, the creature itself would not be that of the present type. In the larval state, no doubt its numbers are greatly checked, being, perhaps, even decimated, by its own imagos, but I cannot see protective colouring in their beautiful metallic brightness; I think their colours have originated through the action of sun-rays during diurnal exposure. As a phase of natural selection, I could perhaps conceive an offspring of resplendent lustre, as the result in time, of the male preferring a bright female, if natural selection could in that way originate it. But unless colour is caused by sun-rays, or originates under its action, how do the first tints appear?

In connection with the subject of sexual selection, I will not here discuss the nature of the eye in *Carabus*, the structure of which is, I consider, an insuperable hindrance to its appreciation of colour. But I will touch on what we all know from a very casual observation of the habits of the lower animals. We know, that when the season of mating commences, there is an eagerness of object, which leaves little room for discrimination of any kind. Those of us who make companions of the canine family know this, and Lepidopterists have seen moths, fresh from the pupa, almost mechanically entering on their relations together. And when bright-coloured males of birds combat in the spring, they are fighting for *a* female, not for the privilege of selecting a favourite in a series.

The *Buprestidæ*, although of a more recent date than the oldest vegetation, are found in the fossil state, and there are, I believe, evidences in well-substantiated facts, that this family are amongst the earliest of known beetle forms. What happens, then, in colour in this family, a family we know has passed through epochs of evolution? Do we find in them protective colouring? In the *Buprestidæ* we have diurnal beetles of the most lovely colours and unclouded lustre, and a vast time can be allotted to them to allow their brilliancy to culminate in its present perfection, and in no other group do we see less of that which is called protective colouring, for they excel in conspicuousness all other beetles. I believe, although I cannot affirm it on my own observation, that *Buprestidæ* infest palms; and palms are older than any flowering shrubs, and, with the exception of a *Curculio* or two, hardly support any other insect-life. *Buprestidæ*, too, are of very simple structure—a cylindrical body without any particularly specialised parts: all this points to an antiquity at least equal to any known in other groups, and in no other family do we see less protective colour. It may be urged that the larvæ feed in the interior of trees, and are protected from enemies which might assail them; that the imago is short-lived, and soon lays its eggs, so that protective colours are not needed; but all I wish to notice is the absence of protective colouring. It is true all are not brilliant; the Madagascar *Buprestidæ* especially are dull and of peculiar form, but the species of that curious fauna are, I believe, not much exposed to the sun; they live under the thick foliage of the jungle. Some of them are brightly metallic beneath, like *Geotrupes hypocrita*, to which I shall refer. The *Phytophaga*, again, are another group remarkable for brilliancy, and have been modified gradually with their food-plants, and there is little or no sign of protective colour in the family. Their tarsi are an instance of beneficial form; certain joints are enlarged, and, absorbing others, have reduced the normal number, giving the feet more power for clinging to plant-leaves and shrubs. Use here has enlarged certain parts, just as the village blacksmith acquires great power in the muscles of the arm. And, while Nature was thus busy modelling and remodelling their form, would not protective colouring also have been given, if it was in any way conducive to the welfare of the species? I think the external physical conditions of life are a much more potent factor in creating form than is usually supposed, for it is these conditions which cause the *Phytophaga* to *want* to cling before the broad tarsus develops.

If we put aside gems and minerals, the colours of which need not be noticed here, the oldest substance or material existing, which throws off, what is called bright colour from its surfaces, is that of living organisms. For their hues are transmitted down through generations and generations from a remote ancestry, not necessarily hereditary, as understood in relation to the sexes, for fuscous ants produce yellow ones; but by reason of an unremitting action of light waves on the surfaces of their outer teguments through all their modifications from the dawn of their existence. The most prevalent colour in the world is that realised in the vegetable kingdom, for in all grades of vegetation a ruling verdure prevails over all other hues, and vegetation is, to say the least, older than the coal-measures. To sustain and render permanent that greenness, which we see so universal in all climates, and under all the possible and most variable physical conditions which exist in the globe, must there not be some persistent, ever-continuing action, which never in all the vicissitudes to which plants are subject relaxes, or suspends, its active operation? And what is this but solar rays, the comparatively unchanging action of the sun? Throughout ages the surface of the globe, with its climate and every physical condition in it, has been changing, yet we believe the foliage of the coal-measures was green.

A simple evidence that greenness in vegetation is owing to light is, that a plant hidden away in a dark cellar grows rapidly and becomes blanched, that is, it ceases when brought to the light to reflect from its leaves green rays, but the relatively permanent character of its organisation soon causes the normal colour to appear on re-exposure to light-rays. Light, while it checks growth in vegetation, has an effect on the material substance of it, and causes it to absorb those rays which make it appear green to us, but when removed from the light it becomes white. Feeding on vegetation, the older organism, as compared to animal life, are green caterpillars, and the greenness of these larvæ, by analogous argument, may be set down as acquired under the same natural processes, for the influences which have acted on the vegetation have been sufficiently continuous on the larvæ to cause them also to absorb the same rays. There is no reason why a caterpillar having a system which can admit light, after the manner of a leaf, should not permanently become green under the same conditions as a leaf, if an adequate time be accorded to it, for light is a movement which is of sufficient energy to act mechanically on such substances as those of which both consist. And from the universal greenness in the vegetable kingdom we see Nature has a general tendency to display this colour in the flora of all countries; and we see it also in other organisms through which light can pass in a like manner as through leaves; and of these I shall speak later.

At a watering-place this summer I saw the shingle of the beach left in ridges by a receding tide, and these ridges were, as any one could see by their continuity along the shore, the result of the wave-movements of the sea. When it was rough the ridges were separated by a wide dip, and in smooth weather the dips were nearer together. They were the result of wave-movement, and corresponded to the motion of the water.

Later, as the tide ebbed out, the more yielding surface of the sand was exposed, which, being flatter than the beach, and the tide on the wane, the ridges or ripples were much smaller and closer together, and, finally, several ridges and dips could be measured in a span's length. In the 'En. Brit.,' under Light, p. 609, I read, "The scales from the wings of butterflies owe their brightness to a delicate ribbed structure"; and I believe that light has acted on the wings of Lepidoptera and other living organisms in a very delicate manner, but in an analogous way as the sea did on the sands. The most beautiful butterflies soar with wings stretched out horizontally, and float backwards and forwards under a vertical sun; while the brown dingy species, flit along hedgerows, with wings half-closed, catching light-rays at all sorts of angles and direct rays very intermittently, and the structural ribs of their scales are modified accordingly. Think of the ripples on the sand and the form they would take in an uncertain, changeable movement of the water; retain in mind the subtle movement of light, the exquisite delicacy of the scales in a butterfly's wing, and the multitudinous angles the superficies of the wings present to the sun during flight, and we can perhaps account for the varied hues of Lepidoptera. The flight of a Skipper would cause its scales to assume a different structure to those in a Blue, just as a cross movement in the sea would disturb the ridges on the shingle. The same theory will explain also the sexual, generic, and family colours of Lepidoptera, for they are dependent on and regulated by the positions of the insects when at rest or during flight; it will explain why *Noctuæ* have different coloured under-wings, as light only reaches them after passing through the primary ones; and why *Geometræ* have wings concolorous, as all four wings are exposed. Remarks later on regarding the atmosphere will apply here. And it will show us another thing more puzzling still.

When insects depart from a type and then again turn towards it, we see forms and colours which surprise us with the similitude they bear to other insects now placed in a classification based on structure, in distant families, and the inquirer is disturbed in his calculations of their affinities. For in this way insects which resemble each other in form and colour are often apparently further detached than others less like them. Now we know that

Pericopis is a moth, and that *Heliconius* is a butterfly, the separation between the two in classification is wide indeed ! But the species, after separating, come together again, inhabit the same glens, live under the same physical conditions, assume the same position in flight and at rest, and, by steps which I think we can trace, similarity of colour and pattern of wing follow. For they both still possess in a certain degree the same internal physiological organisation with which they were endowed before their separation, and this, too, in a comparatively little modified state. It is a point which confirms this view, and carries conviction to my mind, that species of this kind are always found living together, and are subject, therefore, to the same physical conditions. And Nature, acting on a physiological organism not very dissimilar, can produce no other result but similarity of appearance and structure. The conditions I refer to are external conditions, which would, in the ordinary nature of things, act first on the outer characters of a species,—wings, colour, antennæ, and so forth,—while a longer time would be required to modify the more vital parts. Many allied moths resemble the butterflies they associate with, species by species, and I think the above is the explanation of the phenomenon. In the Coleoptera there are also numerous instances. If an African moth resembled an American butterfly, the case would be different ; but, I should still say, that similar conditions of life produced similar results in both continents.

After thinking what insects have passed through, it is natural to turn to the future. But in that we must not assume that existing species can be modified only by a process similar in kind to that which produced them, for then we could not assign to them any continued existence ; but this we may say, that all forms, even those hard and comparatively permanent species now existing in Europe, will through all time continue to be modified under the causes which will be produced by agencies now in operation. We cannot bring the same forces to bear on our domestic animals which Nature has used in forming the parent stock. All we can do is to compare domestic modifications with those variations which are now taking place in wild animals, and this is exceedingly difficult, because the rate at which modifications proceed in the two is so different.

I must refer again to the *Carabidæ* and *Buprestidæ*. In the first family we have noticed that bright species occur in the Spanish mountains in a brilliant sun of a dry atmosphere; colour here is the effect of direct sun-rays, because it is the upper surface alone which is brilliant; *Carabidæ* being on the under surface black. And another thing requires special notice,—the elytra are most frequently of a different tint to the head and thorax. As the insect rambles, the abdomen is carried on in the same parallel line, but the head and thorax move as the animal feeds or runs, and they present to the sun a different superficies, such as has been noticed in the flight of butterflies, and the result is two distinct colours. Many of the *Geodephaga* have the elytral margin alone brilliant, and this is the surface which receives the full force of direct solar-rays; and it is in this spot that colour in many species evidently begins, for even in bright species colour is brightest there. In the second family we find the under surface of the body is as brilliant as the upper, except in the Madagascar species, when the under surface has the greater brilliancy.

Professor Tyndall tells us:—"The heating of the tropical air by the sun is indirect. The solar beams have scarcely any power to heat the air through which they pass; but they heat the land and the ocean, and these communicate their heat to the air in contact with them. The air and the vapour start upwards charged with the heat thus communicated to them." Here is an upward movement, and in the tropics where this takes place we find insects which sit on foliage are brilliant beneath, as the heat-rays, moving upwards, affect the under parts of the beetles in the same way as direct rays affect the Spanish *Carabi*. There is nothing essential in the direct sun-rays of the tropics to create colour quicker or in a greater degree than in temperate zones, but the heat of the air and the moisture there promotes a more vigorous growth in the organisms on which it acts; and perhaps the sun-ray sculpture is rendered permanent sooner there. For there is little doubt that species are less permanent in the tropics than in temperate zones; that is to say, they are more impressible and liable to quicker modification in the same ratio as their vital energy is greater. The winter in our own latitude reduces the growing period of organic life by perhaps one-half, and the feebleness of growth during the other six months lessens it much more.

Regarding the metallic colours of birds, the same mechanical action of the sun's rays seems to produce them. The downy feathers of the brightest are almost colourless, for the light-rays touch the exposed ends of the feathers only. If a swan were dipped into a tub of scarlet dye it would produce a similar effect, and leave the down white. In the humming-birds and swifts, which are continually flying during the daylight, the colour of the under surface of the wings and the sides of the body they cover when at rest corresponds to that of the upper, and the same would occur in dyeing a swan if during emersion its pinions were opened. As the sun-birds fly both sides of their wing-feathers are exposed to the same rays or waves, and the same impressions or ribs are stamped on either side of them, for during the day they are ever on the wing. Birds which perch much have colourless under sides to their wings. Let the humming-bird be thought of in the hovering position of sipping honey, or coquetting on a twig in the midday sun : just as the gorgeous butterflies soar and catch the vertical or direct rays, such, in fact, as appear necessary to produce the right ribbed structure for metallic brilliancy, so these birds are incidentally, by their position, so placed as to be struck by the most direct rays in such a manner as to give brilliancy and metallic colour to the head, breast, &c. The tail is lowered in some species, so that the breast and scalp catch the full power of the sun, and the wings are struck obliquely like those of the brown flittering, or more retiring, species of Lepidoptera. The sun-rays, of course, are not affected by the movement of the wings, but by their varied positions the wings are impressed differently. To appreciate fully the extreme delicacy of the ribbed structure, produced as I think by the sun, is almost impossible; but to see its effect we must face the birds with our heads between them and the light, and then the greatest brilliancy appears, for at any other angle the sculpture is different, less fine, and the brightest colours are lost. It is the same difference as if we looked on the sand from the Folkestone beach, or saw the ripples while wading in the sea. A few of these birds are metallic in a reverse attitude, and it is probable their habits of flight or position in rest are only approximate, for in our classification they stand in different genera. Some have long tail-feathers which float in the air according to the movements of the birds, and these feathers are very beautiful. In the humming-bird, *Orcotrochilus pichincha*, the feathers of the breast are filiform and non-metallic, but in *Topaza piza* the whole breast is clothed with lamelliform feathers, and it is highly metallic. In *Amazilis* the feathers on the rump are laminated and metallic. In others there is another form of feather, a feather, in fact, of filiform structure, which has commenced to be flattened out; here there is metallic lustre, but not the brilliancy of the short lamelliform feather. How far light may be the factor in creating the general form of the feather is a matter of the greatest interest, for it is significant that in birds it requires a lamelliform feather and in butterflies a surface free of hair or down before great brilliancy appears. White birds and white animals belong, generally speaking, to the temperate and northern zones, and the whiteness of a swan may arise from the structural benefit attending that whiteness. The oily substance on the feathers which enables aquatic birds to rest in the water may receive the impressions from the rays, and thus prevent them from becoming permanent on the feathers. Perhaps there is a special absence of this oil on the metallic feathers of the mandarin duck. The swan has the habit of putting his whole neck and head under water, but I doubt if this is so much the habit of the duck tribe when there is brilliant plumage on the head and neck. A laminated feather could not retain oil.

I do not like to refer to tame birds, but the rock pigeon is close to our domestic one, so I take the last as another example. Pigeons strut about the ground picking up grain, moving the head and neck-feathers with a quick undulatory movement, which is almost incessant. The head and neck-feathers meet sun-rays at every angle, and the beautiful tints are diffused, not localised as in the humming-birds.

It is almost a relief to turn from the contemplation of these exquisite structures in birds and butterflies to think of the bark of a cork-tree, or the even rougher hide of a rhinoceros. But in turning round sharply, we see the more clearly, that sun-rays cannot materially affect rude structures like these; and we miss at once what we call beauty of colour. And what do we learn? We see that when Nature has provided the surfaces on which solar-rays can act, metallic brilliancy must come, for it is simply a matter of structure.

When we have a rare plant of tender and delicate foliage, we keep it carefully under glass that the ruder elements may not injure it. Nature, as she prepares the delicate upper surface of a *Morpho*, preserves it from exposure. While direct rays are playing on it, its horizontal wing catches their full force, but in rainy or dull weather the insect rests with closed wings. During the night and the cloudy hours of the day the superficies are thus kept from any influence which might injure their fineness, or hinder their attaining it, for the atmosphere would act in opposition to solar-rays by effacing their sculpture. If butterflies rested like *Geometræ* they would be coloured like any ordinary species of that family. If humming-birds went to roost on exposed twigs I think it would be impossible for them to retain their brilliancy. I do not know their habits in rest, but I have seen the sun-birds of Asia, which have been produced under allied conditions of life to the *Trochili*, retire in cloudy weather. Bright-necked pigeons lodge in holes of rocks. The harder texture of a *Buprestis* can stand nocturnal exposure, but perhaps they have taken longer to attain their colours than a butterfly, and we believe the first is an older form.

From my point of view neither the atmosphere nor any of its components are the cause of bright colour, for it obliterates it. The surface of the hardest granite loses its hieroglyphics by decomposition produced by air. An organic being can retain trivial marks on its most delicate parts through an hereditary system of registration. I think of *Abax striola* as that of an insect which has either passed through the metallic stage, or as one which is attaining it; most likely the latter. It is a very singular thing that the *Hololeptini* are all black; they are diurnal and highly polished. Perhaps these, too, like the cave *Trechi*, are in a transitional position; perhaps the mucous matter they bury themselves in may act like the oil in birds, as suggested here, and prevent them from becoming metallic. This last idea approves itself to me, because in *Teretrisoma* and *Pachycræus*, we have bright diurnal forms of *Histeridæ* which keep themselves free of exuding sap.

Light-rays, as they act on Coleoptera and other insects, require a long time to perpetuate a ribbed structure, but as it is formed by little and little it becomes hereditary in the same way that we know striæ and punctures are.

And the question of the relation between the more palpable structure of a butterfly's wing and the ribbed structure of the scales, which throw off the colour, evidently opens up at this stage of the inquiry. For it seems very possible that light is a powerful factor in modifying the membranous anatomy of a butterfly, or even the harder wing-case of a beetle. I am led to this remark especially now, because I think pigmentary colouring in insects is also due to solar-rays.

In all varieties of man the palms of the hands and the soles of the feet are not exposed, and, like the downy feathers in birds, they are pale in all races. The colouring substance in the cuticle of the negro is said to be a protection against malaria, and as it has originated in an insalubrious climate, which is fatal to Europeans, it seems to me that the ungenial vapours of the swamps in Africa is the condition of life which produces it. But the domiciliary habits of man remove him somewhat from the influences of those laws on which we can with safety rely in our discussion of wild animals.

In an early page of this paper it has been said that nocturnal insects may be black because they are not influenced by the direct rays of the sun, and we have also seen that Spanish *Carabi*, although as brilliant above as the brightest of the *Buprestidæ*, are black beneath. Blackness to a nocturnal beetle is not more of a protective colour than scarlet would be, in fact even less; a scarlet geranium is notably one of the first flowers at twilight to be subdued in colour, and blackness in a *Blaps* would make any stray specimen during daylight, more conspicuous to a sparrow, than if it was banded with blue and gold; the intense blackness would, in fact, sharpen the outline and render it visible at a long distance. If protective colour were beneficial to nocturnal species, would not a large portion of the *Tenebrionidæ* be grey or variegated? In Heteromera, which roam at night, we have more diversity of form perhaps than in any other family of Coleoptera, showing that they have been greatly subjected to modification; so much so, that we can almost think of them, as the nocturnal remnants from ancestors in all the other families, yet they are black, and this means that when they can be seen they are conspicuous. The most inconspicuous or protective colour for any insect is grey or blue-grey, yet in a bright clear mountain atmosphere in Spain, or in the glistening sunshine of the tropics, in places, that is, where it would be most beneficial, such concealing absence of hue is altogether lost. So before we can say this or that is a protective colour, it must be proved that the cause of colour in the animal is not the same as in the plant or object it simulates. And should the animal be a larva, which we believe is of more recent origin than a leaf, we must show that the two, have not been together side by side long enough, to acquire the same tints, by the same processes. It might be said, but I think incorrectly, that blackness arises from the invigorating energy derived from warmth, as blackness absorbs heat-rays, but in that case it would not properly be a protective colour, but an incident in another line of evolution. I have noticed that *Damaster*, seeking for warmth, becomes diurnal, and this, I think, is the natural course for an insect to pursue. I think of blackness as a structure formed by heat-rays, and that beetles are black because from their habits of concealment they are not affected by direct rays, nor by the air like *Noctuæ*.

This will help us to see why *Carabi* are black beneath, for in their dry mountain habitat there is no upward movement as in the tropics. On their upper surface they are sculptured by the direct solar-ray, and their body is the tegument of a nocturnal insect. Wherever there is foliage there is also a certain amount of moisture, and insects, such as *Rhynchites betuleti*, owe their colour to it, and *Carabidæ*, such as *Colpodes* and *Lebia*, of arboreal habit, are not black beneath. *Elaphrus* also, which inhabits a damp swamp, is wholly bright. I must call to mind too, here, the fact, that two arboreal species of *Calosoma*, *scrutator* and *aurocinctum*, found in America, are brightly metallic above and beneath, and that the body in *sycophanta* is wholly black, and I believe the last is terrestrial. *Geotrupes hypocrita*, I think, is bright beneath for the same reason that the Madagascar *Buprestidæ* are, for the fermentation going on in their habitat gives an energy equivalent to the uprising heat-rays of the jungle-forest. If a hand is held out over decaying matter, warmth is felt, something like that which strikes an open palm held out to the sun.

The brightest colours which exist in Nature are those which we see in insects and birds that are the most exposed to the direct rays of the sun, and the brightest and most metallic parts of those birds are those which catch these rays in a greater degree than others. In the humming-bird it is the head, throat, &c.; in the butterfly, the expanse of wing; the one has feathers and the other scales, and these are both of that substance which enables them to take impressions from the sun. The light, direct waves from the sun are the most subtle and delicate of all solar-rays, and produce the finest ribs. Spots and ocelli in Lepidoptera seem to me raised places and depressions in the wings, or are sometimes owing to the different make of scales in those parts. The lamelliform feather of a humming-bird is not very different to the surface presented to the sun in the wing-case of a *Buprestis*.

Opacity of substance is almost universal in the bodies of terrestrial animals and plants, but I will mention two instances of pellucidity. First, the blind *Rhyncophora*, discovered within recent years under stones in the South of Europe, *Raymondia*, *Alaocyba*, *Troglorrhynchus*, &c.; and, second, ferns of the *Hymenophyllum* group. The first live in perhaps absolute darkness, and are never touched during life by light-rays; the second are only subpellucid, and live in the shadiest parts of forests, where they are subject to indirect rays. Cave insects, such as *Trechus* and *Polystichus*, are testaceous, and seem to me to be on the road to pellucidity, but have not yet had time to assume it. If we knew nothing of the laws of light, it would perhaps be natural to look for a general tendency to transparency where the sun's rays are least obstructed, but in reality we must for this turn to aquatics, and look into a pond; there we see numerous examples of it. The larvæ of Neuroptera and *Libellulæ*, shrimps and fishes, are pellucid, because light-rays are diverted from them by refraction, for light glances off sideways on touching the water, and the ribbed structure essential for colour is, generally speaking, absent in these animals. The fish, however, which would feed on the transparent larvæ have eyes formed to see their outlines and movements in the water, just as they have a tail and fins for swimming, and pellucidity in aquatic larvæ is not protective any more than the greenness in the case of *Daphnis nerii*. Light also moves faster in the air than water, so that even if rays acted directly on the integuments of the shrimps, the effect would be less powerful.

The sooner we sift thoroughly the protective colour theory, the sooner we shall discard it, for a better knowledge of the cause of colour in living organisms will dissipate it.

Nature has no multiform manner of working; her energy would be weakened unless based on uniformity of action, but she obtains many ends by the most simple means, and as solar-rays appear to produce metallic colours in insects, so air and its components seem to produce scales and feathers. *Nosoderma* has a weather-beaten cuticle, and so has *Anthribus* and other beetles, which stick to trees in the daytime like *Noctuæ*. The under side of a butterfly is weather-beaten, while we have seen the upper side is protected from nocturnal vapours and bad weather. What happens to the butterfly beneath happens to the moth and beetle above—its surface is weather-beaten. It is the under surface of the moth which would become brilliant if exposed to the sun. In many Lepidoptera the upper margin of the secondary wing, near the base, is covered by the lower margin of the primary wing. The upper surface of this part, the costal margin, has neither colour nor scales. If there were no scales on the under side it would be transparent. This small space is neither sun-struck nor weather-beaten. Attrition is absent. We have said that where direct solar-rays can act permanently on feathers and scales, colour must come; and where air touches the cuticle of animals, there are scales, feathers, and hair. There are no scales or plumes on the wings of insects when the surface is protected from the air, nor is there bright colour in a surface not touched directly by the solar-ray. The under wing of a *Dytiscus*, or a *Lucanus*, is kept from air and light, and it is transparent, that is, it is neither coloured nor scaled. Air, apparently, so universally gives hair and feathers to animals that we think that it is necessary to the welfare of the creatures so to be covered; and it is so, since they have been modified to their present form. But, if air has caused scales and feathers, it is only by acting on a physiological structure prepared by previous modification to be again modified by its power, after the manner here indicated regarding light. For as colour will come on a structure suitable to retain it, whether it be the elytra of a beetle or the lamelliform feather of a bird, so hair will come on animals and feathers on birds through the action of the air, although they may be of no original affinity, or one so remote, that the links of their relationship are lost. As there appears to be a photoplastic process, so there appears to be an areo-plastic process. Wild animals have most hair on those parts most exposed to the weather, just as butterflies have the brightest colours in parts most exposed to the sun and most protected from the elements. The colour of the lichens agrees with that of the *Aplecta tincta*, because they are both weather-beaten; they seldom meet direct solar-rays, and could not retain the impressions if they did, by reason of their present structure.

The form of the lichens is not wholly dissimilar to the form of the scales of the *Noctuæ*, because both, being in the air, are free to develop in all directions. The under wing of *Catocala nupta* has flatter scales than the primary wing, as the upper wing lies over it. I should expect to find the costal margin of the under wing in *Noctuæ* freer of scales and colour than in a *Geometræ*, because the costal margin of the primary wing of the first is robust, and has nervures of thicker structure than the second; and it is the costal margin of the primary wing which rests on the costal margin of the secondary wing. In *Geometræ* the hind portion of the primary wing, that is the thinnest part of it, rests on the costal margin of the secondary wing, and the protection afforded would not be so complete.

I exhibit here two butterflies, *Morpho* sp. and *Nectaria Jasonia*; one has raised nervures, or, to return to the old simile of the sand, here are lateral ridges of rock or chalk, and solar-rays strike a surface unfitted to retain their impressions. In the first the nerves are very fine and delicate, and they permit the wings to close tightly, and the smooth surface is beautifully concolorous. Some butterflies are not brilliant in the wings near the base, as, when the wings are in a position of rest, they do not touch near the body; the wings fit closest about their centre, and this is where bright colour first appears, or in the centre of the spaces between the nerves.

Examine a specimen of *Salpinx superba*, male; this butterfly appears bright in the upper wing just in the part which is in rest most protected from the atmosphere. There is a good wide margin on all sides of it without colour. And then the nerves seem to confine certain spots, which appear spreading, to the centre of the spaces between them, for the nerves meet and press close, and exclude the air, which would obliterate delicate structure on the interstices. The beautiful moth, *Urania*, from Madagascar is highly coloured on both sides, and particularly on the under surface, after the manner of the *Buprestidæ*, and doubtless from the same cause. I look on this moth as one of the oldest forms of Lepidoptera, though not so old as the *Buprestidæ*, for colour would appear sooner on its wings than on the harder elytra of a beetle. How Lepidoptera of this type of beauty preserve their colours,—and there are numbers in the tropics,—I do not clearly see. *Papilio thoas*, too, is worth looking at, as it exhibits a type of pattern common in its family. The pattern of the wing seems regulated by aero- and photo-plasticity ; the yellow band does not pass over the space which is open by the presence of the thorax during rest, and, if the idea of this is carried in mind, it is curious how soon the eye catches its influence as a cause of pattern. These factors are acting in all quarters of the globe on all Rhopalocera ; so there is no reason for seeking affinity where we discover mere similarity in pattern. When butterflies show signs of bright colour in the concavity of the hind wings, it is because this part fits tightly over the abdomen when they rest.

We are fond of speaking of the simplicity of Nature's operations, yet do we always see how really simple it is ? Butterflies and birds living in the air seem to me clothed by it, and they are made beautiful by the solar-ray which passes through it. The complex nature of living organisms is the result of modification through immeasurable periods, not from a complex physiological economy at birth.

When we observe an exceptional structure or colour in an animal, and see the peculiarity repeated, again and again, in creatures which are so wholly different that we can only see this peculiarity to connect them, we are right in thinking there is no real affinity, or one exceedingly remote. But we can trace the origin of the exceptional form or colour to the same source, for we find it everywhere fulfilling the same service. We must, however, look at things closely ; we must not say, that the colour of a *Carabus*, agrees with that of a *Buprestis*, because their tints do not absolutely correspond, and we know something of the reason, as one originates in a clear, dry, mountain atmosphere, and the other in the hot steamy vapour of an undrained jungle.

An instance to show my meaning in colour and form may be given in *Pterostichus picimanus*, *Pedius inæqualis*, and *Achenium humile*, which live in the crevices of clay banks and become piceous, which is a slight indication of a turn towards pellucidity, as they never run in the sun; and they are all flat to enable them to pass into chinks. *Pedius inæqualis* can escape *Pterostichus* by going into the smaller cracks, and the *Achenium* avoids both by passing into the smallest crannies. The flattened form originates in the common benefit to each while inhabiting crevices, and colour follows from the nature of their habitat. The *Pedius* is not necessarily piceous because its allies in the South of Europe, which run in the sun, are coppery or metallic. Another case may be selected of form only. *Lebia* and *Drypta* are both truncatipennes; the first sits on foliage, and continually flies either for pleasure or to escape an enemy, and the shortened wing-case assists this movement. I have seen *Drypta* in great profusion; overtaken by a sudden flood, it will run up a stem of grass or reed to take to flight, and it is in this genus again, we see the truncate elytron, and the use of it. The necessity or benefit of quick flight shortens the elytra very commonly in Coleoptera. The shortened wing-case in the *Staphylinidæ* is different to that in *Lebia*, and arises apparently in another way (see 'Ent. Mo. Mag.,' 1881, p. 138; and 1882, p. 213). Instances such as the above can be multiplied without end, but there is a very striking one in a *Curculio* and a *Staphylinus*. *Balaninus* buries its rostrum in a nut, and the antennæ up to the elbow go with it. In this position the remaining joints play about the eye and fulfil their purpose there. When *Cryptobium* feeds the head and mandibles are thrust into the object they delight in, a decaying worm, or anything else, and the long basal joint brings the small joints of the antennæ behind the eye. The common origin of the long joint here is, I believe, the dimness of sight in both animals, which necessitates the feelers being brought back. The varied species of *Balaninus* show what immediate modifications the genus can go to. The long joint of the antennæ in the two genera shows that like wants, arising in like conditions, give like form. In *Rhynchites* and *Apoderus* the head is not inserted into their food-plants, nor are the antennæ elbowed.

Perhaps it will be said that these are interesting facts about the *Drypta* and *Balaninus*, and that they are such as should be brought forward; but do they cover the conclusions? I am merely applying to details in structural and other peculiarities what we learnt in our childhood: an eye is for seeing, an ear is for hearing. If we are frustrated in an effort to discover why a glowworm is phosphorescent, let us examine a May-fly (*Teloganodes*), or a centipede, which is luminous, and if we discern a reason for its existence in either one or the other, it will lead us to the cause in all. If we say a leg is for walking we err; we must say a leg is for moving. If we see a brown beetle clinging to brown bark, we do well to say the brownness in both arises from the same cause; but if we believe in the protective colour theory, we must say that one of the primary uses of the clinging foot to a brown beetle is, to enable it to cling close to bark where its concoloration will enable it to escape extermination. I believe the clinging tarsus is an independent modification arising from habit, and that colour is a modification dependent on that structure only so far as it will come to any creature which will inhabit similar situations.

In colour, let me give three more examples: a leaf, a *Sphinx* larva, and *Cassida viridis*. Light affects these in the same way, or nearly so, because they are not very dissimilar in substance, when considered merely in their relation to light. Certain light-rays can pass through them in a similar way, for they are translucent, and this causes a sameness of colour. The *Cassida's* body is black, for it is of a different texture to its case. In Ceylon, and in other places, are certain Reptilia, snakes, frogs, and lizards, which possess skins of marvellous delicacy; they are semitransparent and admit certain light-rays to pass through them; their whole physiological structure, too, is such that light is admitted into their material substance; they sit on foliage, where they are exposed to all the waves of solar-rays and heat, just as leaves are, and they are green. But remove them to a trunk, shaded, or partially so, from the direct rays of the sun, and the reptiles become mottled or brown, as the case may be, for their mutations are too variable to describe; their colours differ at each hour of the day, and are affected by almost every passing cloud. Their material substance is such that they become green where *Cassida viridis* is green, and mottled where a *Noctua* is mottled.

If like conditions and wants produce a like form, what is more certain than an offspring should resemble its parent until removed from the conditions under which that parent lived? And it appears to me to be under impulses somewhat akin to these that hereditary form owes its origin.

Since writing the foregoing I have read Dr. Hagen's paper in the 'Proc. Amer. Academy,' April, 1882. The conclusion arrived at in this paper regarding colour is: "I am convinced," says the author, "that colour and pattern are produced by physiological processes in the interior of the bodies of insects." Dr. Hagen's observations and inferences are wholly different to mine, but Dr. Weismann is quoted, who believes that colour and pattern in caterpillars is "purely mechanical;" and this process is what I consider has been and is open to proof. Dr. Weismann seems to have confined his observations chiefly to caterpillars, because "they exclude sexual selection;" but if sexual selection is a factor (I exclude it altogether as regards colour) it must act through the imago on the ova and all the intermediate stages of an insect, for in one sense the imago is only a form of puberty.

I now return to the original subject of this note. Motschulsky, in his diagnosis of *Damaster rugipennis*, says, "in ♂ tarsis anticis articulis tribus primis leviter dilatatis, subtus spongiosis et biseriatim setosis," and *D. Fortunei* also has the tarsi of the male with three joints dilated and padded beneath, and these two species bridge over the distance between Kollar's genus and *Carabus* proper. When Kollar published his species he only knew of the leptodactylous *blaptoides* with long mucrones, and he thought these sufficient characters on which to found a genus. In *D. capito* we have a species with slender tarsi in the male, and obtuse elytral points in both sexes, and it is impossible now to consider *Damaster* any more than an endemic form of a Japanese *Carabus*. *Damaster viridipennis* I now know is the same species as *Fortunei*, Adams; the type of the latter is in my possession, and is discoloured by emersion in spirit, and the author of the species was not aware of the beautiful colour of fresh specimens. For the slender blue variety in *pandurus* I have noticed as occurring in the mountains of Chiuzenji, lat. 36° 30″, I propose the name of *cyanostola*; it is a form quite isolated from the parent type, and corresponds to *Lewisii* in *blaptoides*, with this difference :—*Lewisii* is an offshoot of *blaptoides* rendered smaller by the dryness of the area it inhabits, as compared to the district of luxuriant vegetation in which *blaptoides* dwells; it is not a variety owing to a dry mountain atmosphere, but a variety pertaining to a dryer, lighter soil, of the same elevation. *Cyanostola* is a *pandurus* which has wandered up from the coast-level, where snow rarely lies, to an altitude of 6000 feet, where snow remains six months in the year. Alpine insects, which crawl out from the snow to enjoy the bright sunshine of an instantaneous spring, often acquire in it, as we have seen, colour which enables them to vie with the gorgeous insects of the tropics. If in the latitude (33°) of *blaptoides* there were high mountain ranges suited to *Damaster*, we should probably have a coloured *blaptoides*, but the altitude to produce the necessary lower temperature would have to be greater than that in latitude 36° 30″. As it is, the only mountain near to Nagasaki of sufficient altitude is Unsen, 7000 feet, but this volcano is merely a conical mass of lava thrown out by recent eruptions, and is at present unfitted to nourish either vegetation or large insects.

Having said then that the characters are insufficient on which Kollar relied to separate *Damaster* and *Carabus*, let me examine *seriatim* the ordinary forms of the genus, and note their differences in the various latitudes they inhabit, for we shall find that they too follow the same line of modification, and, under the same climatic and thermal changes, exhibit similar variations to their allies.

In the first section there are five species close together, and their connecting history appears to be this :—

Carabus Dehaani is a large dark-coloured species of nocturnal habits, confined to the warm area south of the Biwa Lake. It is abundant, and constant in form and colour, from Kagoshima to Kioto, a distance of 400 miles, and also occurs in Tsushima and on the south of the Korea, which gives it a fairly wide range, and seems to indicate that it has in all probability allies in Eastern Siberia.

Carabus insolicola is a modified form of *Dehaani*, and, like it, does not vary; but it is diurnal and bright-coloured. It has equal possession of the colder latitudes, reaching from Biwa Lake to Awomori, an extension of 500 miles. The two insects are locally separated from each other by the Biwa Lake barrier, north of which the climate of Japan is much colder, owing to the higher mountain ranges which run up the centre of the main island, and, partly because there, the effect of the Kurosuwo, or gulf-stream, on the general temperature is lessening as the stream begins to pass away eastward into the Atlantic.

Carabus Albrechti is another abundant species, a scion branching out of one of the above, and is a more prevalent form than either of them, for the climate permits it to retain its specific characters, subject to very slight variation in all the islands, and it is spread over a space equal to 1300 miles. Yet still, even in this species, the southern specimens can be distinguished from those of Hokkaido by a slightly more graceful outline, somewhat more slender legs, and a rather less coppery colour. From the southern type of *Albrechti* emanates *Maiyasanus*, which is limited to a comparatively small area, and then occurs only at considerable elevations. The head-quarters of it are in the Idzu Province, but I have specimens of it from Oyayama, near Kumamoto, in Kiushiu; the distinguishing character of it is the constant pale tibiæ, while all other known *Carabi* in Japan have dark-coloured legs.

Carabus Yakoninus is an offshoot from *Dehaani*, and we find it existing only in that part of Japan where the parent type is abundant; both reside side by side, and if intermediate varieties could be procured the short distances between them would be bridged over. But I failed to find any form of it in the north with *insolicola*, nor could I obtain any varieties in the south. The most notable feature of this transitional species is that it is well marked in colour as being nocturnal, and therefore, like *Dehaani*, suited to the mild climate of Kiushiu, where it is found.

In another section of the genus, *Carabus Maacki*, similar variations appear. A series from Tonasawa, lat. 35°, is black; these represent *Carabus telluris*, n. s.; while specimens of Moriwitz's type from Sapporo, lat. 43°, are distinctly green and metallic.

In a third section, represented by *Carabus procerulus*, which occurs from Kumamoto to Awomori, I found near Sapporo an allied species, *arboreus*, n. s., which is more robust and less elegant; the climate in this species affects form only. These two species run parallel to *Damaster blaptoides* and *Lewisii*, for both are nocturnal, and present to us the first effect of thermal change, *viz.*, a structural modification, such as commonly occurs in the flora-world when at the base of a mountain plants show a vigorous growth and attain a large size, while specimens higher up the mountain gradually diminish.

Mr. Pryer has told us in a recent paper that certain thermal or "temperature" forms of butterflies occur in spring and others in summer, and that the forms are regulated by the temperature in which the larvæ live. And this is not hard to understand. In Japan spring forms of Lepidoptera come from larvæ fed up on autumnal foliage, on leaves, that is, which are fully matured, if not partially desiccated; but the summer broods are nourished on the succulent vegetation of early summer. The nutritive properties in plants vary as their growth is vigorous, or otherwise; hence the small mountain varieties of summer agree with those of the spring in the valleys. Larvæ reared on a patch of poor soil in the midst of a fertile valley would give a corresponding result. In the tropics the secret of the "luxuriance lies in the copious rain," as I said, in August, and the large size of insects in the tropics is owing to their association with, and dependence on, the flora, and the conditions which affect both alike. A collection of British beetles I can store in a cabinet of fifteen drawers; a collection containing the same number of species from a country even as far north as Japan occupies forty.

I believe I have traced here in *Carabus* the same lines of variation which I noticed three years since in *Damaster*, viz., that a robust or stunted form is an earlier stage in thermal modification than colour, colour appearing only as an insect requiring warmth becomes diurnal. The discovery of the beautiful *Carabus Gehinii* in Hokkaido has introduced into the fauna of Japan an entirely new phase of diurnal *Carabus*, and, although this species at present stands apart from the other members of the genus, we cannot fail to observe that its colours are subdued, and by analogy we can anticipate the finding in Saghalien of northern affinities which will be as bright as the European *auronitens*.*

* Mr. Bates has just received this form in a fine new species from lat. 46°.

It may be suggested that if what I have said regarding sun-ray structure is correct, the matter may be proved once for all, by measuring the striæ or ribs on a scale or feather. For we know the lengths of solar-rays, and if the striæ correspond with them, this evidence may be accepted as a proof of their origin. But "a common sunbeam," says the author quoted, "contains waves of all kinds,—besides those which produce light, the sun sends forth incessantly a multitude of waves which produce no light. The largest waves which the sun sends forth are of a non-luminous character, though they possess the highest heating power. The lengths vary from about 1-30,000th to 1-60,000th of an inch." Any structure, therefore, produced by the direct solar-rays would not, even if the object impressed were rigidly stationary, tally with any particular measurement. Yet with this, it would be a test of no mean value to measure the colour-giving striæ of *Geotrupes hypocrita*, and compare them with those on the under surface of *Polybothris*, and these again with the striæ on *Carabus Hispanus* and *Pterostichus metallicus*, for the sculpture should not be so fine on the first and second as on the two others. *Geotrupes auratus* is an insect on which both kinds of striæ are found, one on the upper, the other on the lower surface; the first reflects red, the second golden green, and these colours closely agree in their respective parts to those seen in *Polybothris* and *Carabus*.

Here I may again call attention to the peculiar geographical position and varied climates of Japan, to which I formerly referred in the note on *Damaster*, for it enables us to trace in the islands, more clearly than any other area of the globe, the climatical influences which everywhere multiply species, and give so much diversity to the faunas of the world. And it necessarily follows that allied influences are at work on the great continents of Asia and of Europe, but why do not the characters here spoken of reveal themselves as conspicuously in the *Carabi* of the European catalogue? In Europe there are broad areas with lateral mountain ranges, and species are not forced to extend themselves solely to the north or to the south; and continents admit also of migration from east to west and from west to east, and early divergent geographical forms would mingle together and after a time return perhaps to the home and habits of their predecessors. Thus, as generations slip away, the simple history of climatic and thermal modification is lost, or at least so far obliterated that we cannot easily define the limits to which it goes, although probably in the earlier stages of divergence the characters were stamped on the species in the same clear manner which we see still existing in the Japanese members of the family.

For the sake of following out the system employed in the earlier note (1879), I have said that *Damaster* became coloured, &c., as it approached the north, but it does not affect the general argument if it has spread the other way. *Carabus* is known to be a northern genus, and as *Damaster rugipennis* and *Fortunei* more nearly approach the type than the others, it is of course probable that the southern species are those which have been modified most, because they have been subjected not only to the changing conditions of the globe generally, but by migrating southwards they have passed voluntarily into a subtropical region.

If eventually we do not find in the north a coloured species allied to *procerulus*, I am inclined to think of it as a recent divergence, a species now in the act of spreading, and not yet differentiated into all the forms which Nature appears as a rule to lead to in this genus. For we all know that species have a very great tendency to inherit the form and habit of their kind, and to remain unaltered for some time; but at last the tension is too great, the conditions of their lives must act, the line breaks, and then comes the variety which originates a new race.

We cannot return to the time when *Damaster* and *Carabus* agreed better in outline and general contour than at present; we can merely trace their transitions by a general system of analogy, but in studying close varieties we study evolution, as it were, on the spot; we see divergencies in their most recent forms, and even perhaps as they are taking place. Seeing this then, may it not be well to but lightly censure "splitters" of species who are recognising transitional forms such as are as surely, and, presumably, as rapidly, departing from the type as any species since the time of the earliest insects? Names need not always be given, for we have passed the line where catalogues are useful,—we have reached the frontier, so to speak, of evolution, and beyond us lies the future in which Nature will not recognise any arbitary classification; for then, as in the past, she will simply continue the inevitable modifications of surviving organisms through the means of the agencies which will result from those which are, as we have said, now in operation. And when that future shall have become the present the descriptive matter of to-day will not apply to existing forms, but instead of an abstract idea of the differences in insects, we may have a more certain knowledge as to their origin, and the working of those laws which both accelerate and control their development.